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RESEARCH ARTICLE

Parental locus of control and the failure to obtain a child diagnosis: a longitudinal cohort study [version 1; peer review: 1 approved with reservations]

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Abstract

Background: Data from the Avon Longitudinal Study of Parents and Children (ALSPAC) were analysed to investigate associations between parents' locus of control (LOC) and their use of their children's symptoms to pursue a diagnosis of autism.

Methods: Comparison of parental LOC obtained prenatally with various aspects of the child's (<12 years) development, used the prevalence of four autistic traits, to ascertain the likelihood that they qualified for an autism diagnosis.

Results: Parents with an external LOC had children who were more likely to demonstrate extreme levels of each of the four autistic traits (e.g. for social communication 8.9% of offspring of internal LOC versus 12.3% of external LOC mothers; $P < 0.0001$). However, the rate of autism diagnosis was considerably greater if the mother was internal compared to external (13.3 v 9.6 per 1000). To determine whether the difference was autism specific, we compared parental LOC with children diagnosed with dyslexia and those with reading impairments. Although externals' children had more reading impairment indicators than internals, this was not reflected by them being more likely to be diagnosed as dyslexic.

Conclusions: We conclude that children of parents with an externally oriented LOC may be less likely to be diagnosed appropriately than children of internally oriented parents. Interventions to increase parental internality may improve the likelihood of appropriate diagnoses and hence an improvement in child well-being.

Keywords

ALSPAC, autism, parental locus of control, obtaining diagnosis, dyslexia

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report

1. **Ginny Russell** ^{id}, University of Exeter, Exeter, UK

Any reports and responses or comments on the article can be found at the end of the article.



This article is included in the [Avon Longitudinal Study of Parents and Children \(ALSPAC\)](#) gateway.

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Introduction

Increasing rates of children identified as having an autism spectrum disorder (ASD) is note-worthy (e.g. [Idring et al., 2015](#); [Jensen et al., 2014](#); [Nevison, 2014](#)), although there is some evidence that much of the rise in numbers reflects increased awareness ([Lundstrom et al., 2015](#)). Regardless of the reasons, the fact that more children are receiving an ASD diagnosis presents a challenge to health and education services who have the responsibility to provide appropriate facilities to enable children with ASD to reach their full potential. To receive services in Britain though, ASD children must be brought to the attention of health and education services. However, some children with ASD are not diagnosed as quickly as they could be. Because early diagnosis may lead to more effective outcomes ([Wong et al., 2015](#)), identification of parental characteristics that help or hinder an early diagnosis of childhood autism is important. This study tests whether individual differences in the personality characteristic, locus of control (LOC), has such an effect.

LOC as conceptualised by [Rotter \(1966\)](#) within his social learning theory is a “generalized problem-solving expectancy” learned in childhood via interactions with parents and through interactions with peers and other adults. Internal LOC (ILOC) and external LOC (ELOC) individuals have different approaches to solving problems because of their differing learned expectancies about their role in solving them. Internal problem solvers tend to be governed by a learned expectancy that their efforts can affect success or failure in contrast to external problem solvers who depend, for their success, more on luck, fate, chance or powerful others, rather than on their own efforts.

[Nowicki \(2016b\)](#) characterised the differences in problem solving behaviours associated with internality and externality thus: when facing a problem-solving situation, internals are more likely than externals to: (1) take responsibility for what they have done; (2) be persistent in their efforts; (3) delay gratification; (4) gather information; and (5) resist being coerced. Consequently, the problem-solving tendencies of internals usually puts them in a more advantageous position than externals.

Research findings generally support the theorised advantages of internality versus externality. More favourable outcomes of ILOC are found in higher academic achievement (e. g. [Flouri, 2006](#); [Kalechstein & Nowicki, 1997](#)), better sports performance (e. g., [Arnaud et al., 2012](#)), and business success (e.g., [Spector et al., 2002](#); [Wu et al., 2015](#)) and less favourable outcomes are associated with ELOC including negative personality characteristics (e.g., [Duke & Nowicki, 1973](#); [Wheeler & White, 1991](#)), depression ([Benassi et al., 1988](#); [Bjørkløf et al., 2013](#); [Christensen et al., 1991](#)), anxiety ([Carden et al., 2004](#)), and psychoses ([Harrow et al., 2009](#); [Weintraub et al., 2016](#)).

Though relatively few LOC studies have focused on parents and parenting, one consistent result has been found: externality in one or both parents has been associated with more negative outcomes in the children, whether the outcomes were measured in preschool (e.g., [Estroff et al., 1994](#)); preadolescent or adolescent participants (e.g., [Freed & Tompson, 2011](#)). While cause and

effect are difficult to determine, we ([Nowicki et al., 2018a](#)) found that parents who became more external over a six-year period had children with a greater number of teacher-rated difficulties on the Strengths and Difficulties questionnaire (SDQ) ([Goodman, 2001](#)) than those who were external but became internal over time. Such a result suggests that parental changes in LOC may affect their children’s behaviour.

The questions we seek to answer here are whether parental LOC is associated with: (1) higher levels of ASD traits, and/or (2) a diagnosis of ASD. We predict that internal and external parents are likely to be triggered to solve the problems presented by children showing ASD characteristics differently. First to obtain the help they need, parents must be aware that their child is having difficulties and then, more importantly, they must use the information they obtain to get help for their child which in this situation is probably best obtained with a diagnosis. While our main interest was in finding out how LOC is associated with the actions of parents of ASD children, we suspected the same results would be found for other problems presented by their children, such as dyslexia. As a secondary research question, we investigate whether the associations with LOC differ with the parents’ social circumstances.

Methods

Study sample

The Avon Longitudinal Study of Parents and Children (ALSPAC) is a cohort study of children born to women resident in Avon (south-west England). The overarching aim of the study was to determine ways in which the environment, in conjunction with the genetic composition of the family, influenced the child’s health and development ([Golding et al., 2001](#)). All pregnant women with an expected date of delivery April 1st 1991–December 31st 1992 inclusive, residing in Avon were eligible to take part. There were no exclusions other than deliberate refusals. Avon comprises a mixture of urban and rural areas – including the city of Bristol, large and small towns, small villages and agricultural areas.

The initial enrolled sample consisted of 14,541 pregnancies. Of these, there was a total of 14,676 fetuses, resulting in 14,062 live births and 13,988 children who were alive at one year of age. 94% of the 13,988 surviving children were white Caucasian. Information on the cohort parents and their offspring was collected using a variety of methodologies: self-completion questionnaires (study mothers, fathers, teachers, study child); direct examination under standardised conditions; linkage to medical records and data from the education system ([Boyd et al., 2013](#); [Fraser et al., 2013](#)). Details of all the data that are available through a fully searchable data dictionary and variable search tool are on the ALSPAC website: <http://www.bristol.ac.uk/alspac/researchers/our-data/>.

Ethical approval for the study was obtained from the ALSPAC Ethics and Law Committee (ALEC; IRB00003312) and the Local Research Ethics Committees ([Birmingham, 2018](#)). The data collected for this study used a mixture of self-completion questionnaires completed by the child’s main carer (usually the mother), reports from the child’s teacher, diagnoses identified in

maternal report and/or medical and educational records. Consent type differed with the source of data. Those that occurred in a face-to-face contact with ALSPAC staff required signed consent from the parent and assent from the study child. Detailed information on ethical approvals and the ways in which confidentiality of the cohort is maintained is on the study website: <http://www.bristol.ac.uk/alspac/researchers/research-ethics/>

The exposure

Rotter defined LOC as follows: “Internal versus external control refers to the degree to which persons expect that a reinforcement or an outcome of their behaviour is contingent on their own behaviour or personal characteristics versus the degree to which persons expect that the reinforcement or outcome is a function of chance, luck, or fate, is under the control of powerful others, or is simply unpredictable. Such expectancies may generalize along a gradient based on the degree of semantic similarity of the situational cues” (Rotter, 1966).

The LOC measure used in the present study was administered in self-completion questionnaires individually to the mother and to the study father during pregnancy. It is a shortened form of the adult version of the Nowicki-Strickland Internal-External LOC scale (ANSIE) comprising 40 items in a yes/no format to assess perceived control (Nowicki & Duke, 1974). This measure was chosen over other scales more specifically related to perceived control over health, as it was considered that this more generalized scale would relate to other factors in addition to health outcomes. Construct validity for the scale has been found in the results of over a thousand studies (Nowicki, 2016b). The version used in the present study comprises 12 of the original 40 items which were chosen after factor analysis of the ANSIE administered as a pilot to 135 mothers. The 12 questions loaded onto a single factor of general LOC. The 12 questions used are shown elsewhere (Golding *et al.*, 2017a). From the responses a ‘LOC score’ was derived: the higher the score the more external the LOC. The scores ranged from 0 to 12. For this study, ELOC was defined as having a score greater than the median (i.e. >4 for women and >3 for the men). This cut-off identified 45.2% of the women and 46.6% of the men as externally controlled.

The outcomes

ASD outcome measures

As in previous studies from this cohort (Culpin *et al.*, 2018; Golding *et al.*, 2017b; Rai *et al.*, 2018), in order to assess associations with ASD we not only use the diagnosis but also measures of autistic traits (see below). A polygenic risk score for autism, devised from non-ALSPAC data has been shown to be associated with both the diagnosed cases and the extreme scores on each of the trait measures within ALSPAC (Rai *et al.*, 2018).

Identification of diagnosed ASD

Identification of children with autism employed the following sources: (a) review of health and other records of all children given a statement for special educational provision in the Avon area to identify children diagnosed by age 11 as having special

educational needs and conforming to a diagnosis of ASD using the ICD-10 criteria (Williams *et al.*, 2008); (b) the mother’s answer to the question at age 9 ‘Have you ever been told that your child has autism, Asperger’s syndrome or autistic spectrum disorder?’; (c) classification as Pervasive Development Disorder using questions from the DAWBA questionnaire at 91 months (Goodman *et al.*, 2000), with the answers to the questionnaire classified by a child psychiatrist; (d) text responses to any question on diagnoses given to the child in questionnaires from 6 months to 11 years concerning results of investigations; (e) ad hoc letters from parents to the Study Director. We considered that no one of these sources would be adequate, and so used all, and monitored the overlaps (In preparation). A total of 177 ALSPAC offspring were identified as having a presumed diagnosis of autism – 139 boys and 38 girls.

Autistic traits

We have identified individual children with extreme scores on the four independent traits identified previously as most predictive of autism in this cohort. They included measures of social communication, coherent speech, sociability temperament and abnormal behaviour (including repetitive behaviour). The most extreme decile of each scale was shown to be independent predictors of autism as identified using health records (Steer *et al.*, 2010).

The social communication trait

The 12-item Social and Communication Disorders Checklist (SCDC), was developed by Skuse & colleagues (2005), who demonstrated an excellent internal consistency (0.93) and high test-retest reliability (0.81). Using the ALSPAC population at age 7.7 years the high end of the scale was shown to predict a variety of adverse outcomes, but was most specific for autism spectrum disorder (Skuse *et al.*, 2009). We have used the prorated score, calculated when any items of the scale were missing a response, by using the average of the items that had been answered by the individual (2.7% of the population, almost all of whom had just one item missing). If all items were missing, the score was put to missing. The measure ranged from 0 to 24, the higher the score the more impaired was the child’s social cognition. The distribution was skewed with a long upper tail (12.8% had a score of over 6 and comprise the abnormal group for these analyses).

The coherence trait

The first version of the Children’s Communication Checklist (CCC) was completed by the child’s mother when the child was 9 years of age (Bishop, 1998). This was designed to identify aspects of communication that are not readily assessed by conventional standardized tests, including aspects of speech and syntax as well as pragmatic aspects such as over-literal interpretation of stereotyped language. Although initially designed to identify pragmatic difficulties, it discriminates between a wide range of language and communication problems (Bishop & Baird, 2001). Analyses of traits predictive of autism in ALSPAC showed that the Coherence scale performed better than the other CCC scales (Steer *et al.*, 2010) and consequently it is

used here. It comprises eight items (e.g. 'It is sometimes hard to make sense of what he/she is saying because it seems illogical or disconnected' and 'He/she has difficulty in telling a story, or describing what he/she has done in a sequence of events'). The score ranges from 20 to 36, with higher scores indicating more typical behaviour. The score had a skewed distribution. The lower tail used in this analysis comprised those children scoring ≤ 33 points (10.0% of the population).

The abnormal and repetitive behaviour trait

This scale was developed from the answer to four questions in the questionnaire sent to the mother at 69 months: 'How often does he/she: (a) repeatedly rock his/her head or body for no reason; (b) have a tic or twitch; (c) have other unusual behaviour'; or (d) 'Does he/she stumble or get stuck on words, or repeat them many times?' (e.g. I I I I want a sweet)? The responses to each question were coded as often/always = 3; sometimes = 2; never = 1 and summed. The resultant scale had a range from 4 to 12, with 22% scoring 5 and only 5.9% scoring more than 5. Thus, it was impossible to approximate to a 10% cut-off; we therefore used >5 as our abnormal group.

The sociability temperament trait

The study mothers completed a questionnaire when the child was 38 months of age which included the 20 questions of the EAS Temperament scale (Buss & Plomin, 1984). This identified four traits: emotionality, activity, shyness and sociability; each based on the answers to five questions. The range of the Sociability sub-score was from 5 to 25 and the frequency distribution was approximately normal, a high score indicating a high level of sociability. The prorated scale was calculated for missing values as in the scales mentioned above. We then selected the lowest 11.4% of the children for our analyses (score <8) as being the nearest to 10%.

Dyslexia outcome measures at age 9

Identification of dyslexia was used as a comparison to the autism findings. This comprised a binary answer to a questionnaire administered at age 9: 'Have you ever been told that your child has dyslexia?' For comparison we used the pattern of spelling, reading and phoneme abilities of the children at age 9, tested by trained ALSPAC research psychologists and speech therapists in a clinic setting. These include the following tests:

Spelling

At age 9-years a spelling test was administered to the study children. A total of 15 words were chosen specifically for each age group after piloting on several hundred children in Oxford and London by Peter Bryant and Terezinha Nunes for this project. The spellings involved regular and irregular words of different frequencies. They were given in order of increasing difficulty as identified from the pilot studies. For each, the word was read out loud to the child, and then within a specific sentence incorporating the word, and then alone again. The child was asked to write down the spelling even if they thought they were just guessing at the spelling. The spelling score was the number of words spelt correctly (range 0 – 15).

Reading

Word reading. The child was asked to read aloud ten real words selected from a larger selection of words taken from research conducted by Terezinha Nunes and others in Oxford (Nunes *et al.*, 2003). The set of words was specifically chosen for this study by Nunes and Bryant. Under test conditions, the child was shown each word in turn and asked to read the word out loud. The test-retest reliability of the word reading was 0.8, and the scale had a correlation of 0.847 with the Schonell Word Reading Task (Schonell & Goodacre, 1971). The word reading score was calculated as the number of words read correctly (range 0–10).

Comprehension. The revised Neale Analysis of Reading Ability (NARA II) (Neale *et al.*, 1997) was used to assess the child's reading skills and comprehension. This test is said to be suitable for children between the ages of 6 and 12 with a standard assessment time of 20 minutes. The testing took place in a quiet room. Wherever possible, parents were asked not to accompany their child into the testing room in order to minimize distractions and interruptions. A booklet was used from which each child read a passage, they were then asked a series of questions about the content of the story they had just read. For each question the child was given 10–12 seconds to respond; they were permitted to refer back to the text to assist them. The raw comprehension score was obtained by summing the number of correct answers the child gave for each passage. The raw score was standardized for age using the authors' criteria.

Reading speed. Using the times taken for the child to read each passage in the comprehension test, a speed rate was computed. This was based on only those passages actually read where no more than 16 errors were made and was calculated as:

$$(\text{Total no. words read} \times 60) / (\text{Total time taken}).$$

Reading accuracy. The raw accuracy score was computed as the total number of errors made by the child in all the passages that they read, such that the higher the score the worse the accuracy.

Phonemic decoding efficiency (non-word reading). This was assessed by asking the child to read aloud ten non-words. These were selected from a larger selection of words taken from research conducted in Oxford (Nunes *et al.*, 2003). It was emphasized to the child that because the words were made up the child would not recognize them as real words. The children were asked to read them in the way that they thought they should be read, even if they were guessing. The tester recorded whether the child pronounced the word correctly or incorrectly. 'Partly correct' was recorded if the child split the word into the appropriate syllables correctly but mispronounced the word in some other way. The number of non-words correctly read was scored. The distribution was approximately normal.

Statistical analysis

This study was designed to be a descriptive search for pattern. We compared the prevalences of the extreme end of each trait measure for the offspring of internal compared

with external parents. The ratio of the two prevalences was computed (external/internal) together with the P-value based on the chi-squared test. We then stratified according to the combination of externality and internality in the partnerships using chi-squared for a 4 x 2 table. Finally, considering that a person's LOC predicts their educational and occupational level it was inappropriate to adjust for such measures. However, to account for possible differences in outcomes related to different social classes, we compared the results according to the social class of the family as based on the current (or latest) occupation of the offspring's father during pregnancy (Office of Population Censuses & Surveys, 1991). The data were stratified into Non-manual (social classes I, II and IIINm), and Manual (IIIM, IV and V) occupations, and analysed separately. Mothers whose partners were never employed, or an unclassifiable occupation, or in the armed forces or students were omitted as were those women without a current partner.

Results

Autism and autistic traits

In Table 1 the prevalences of the individual autistic trait measures are shown in regard to the LOC of the child's mother. There is a clear pattern for each trait, with the children of external mothers being significantly more likely to be classified in this way compared with the children of internal mothers (prevalence ELOC vs ILOC was between 33% and 43% greater). This is in contrast with the prevalence of diagnosed autism which was 1.33% among children of ILOC mothers, but only 0.96% when the mother had an ELOC LOC.

Data concerning the father's orientation is shown in Table 2. Although mainly statistically significant the ratio between the external and internal fathers of the prevalences of the abnormal levels of the traits ranged from 1.14 to 1.25, considerably less than found for the mothers (range 1.33 to 1.43), indicating that the relationship with the mothers' externality was stronger than that of the father.

Table 1. Prevalence [n] of autism and severe autistic trait scores on measures of social communication (SCDC), pragmatic language (CCC coherence), repetitive behaviour and sociability temperament (EAS) by maternal locus of control as measured in pregnancy.

Outcome	ILOC prevalence	ELOC prevalence	ELOC/ILOC	P - value
<i>Traits</i>				
SCDC	8.39% [401]	11.99% [361]	1.43	< 0.0001
Coherence	8.85% [410]	12.26% [356]	1.39	< 0.0001
Repetitive	6.23% [259]	8.30% [244]	1.33	< 0.0001
Unsociable	9.78% [551]	13.59% [543]	1.39	< 0.0001
<i>Diagnosis</i>				
ASD	1.33% [90]	0.96% [58]	0.72	0.030

ASD, autism spectrum disorder; ELOC, external locus of control; ILOC, internal locus of control; SCDC, social and communication disorders checklist.

Table 2. Prevalence [n] of autism and severe autistic trait scores on measures of social communication (SCDC), pragmatic language (CCC coherence), repetitive behaviour and sociability temperament (EAS) by paternal locus of control as measured in pregnancy.

Outcome	ILOC prevalence	ELOC prevalence	ELOC/ILOC	P - value
<i>Traits</i>				
SCDC	8.68% [291]	10.71% [271]	1.23	0.003
Coherence	8.95% [291]	11.23% [256]	1.25	0.001
Repetitive	6.54% [193]	7.48% [193]	1.14	0.095
Unsociable	10.01% [391]	12.38% [391]	1.24	< 0.001
<i>Diagnosis</i>				
ASD	1.46% [66]	0.98% [44]	0.67	0.012

ASD, autism spectrum disorder; ELOC, external locus of control; ILOC, internal locus of control; SCDC, social and communication disorders checklist.

Table 3 shows the associations when the orientation of the two parents are considered together. For each abnormal trait, the prevalence is lowest when both parents are internal, it increases slightly (with the exception of repetitive behaviour) with internal mothers and external fathers, is higher still with external mothers and internal fathers, and at its highest when both parents are external. In contrast, the prevalence of diagnosed ASD remains in the region of 1.28–1.59% for the first three of these categories but is significantly lower when both parents are external (0.81%).

These data may be interpreted as showing that:

- The prevalence of the traits that are independently associated with ASD varies with the LOC of the parents such that the more external they are the higher the prevalence of these traits.
- The prevalence of the extreme levels of the trait measures was particularly high if both parents were externally oriented.
- In contrast the identification of the children with diagnosed ASD was particularly low if both parents were externally orientated.

Dyslexia and traits relating to reading, spelling and phonemic decoding efficiency

In order to determine whether the link between external parents and a reduced likelihood of obtaining a diagnosis was specific to autism, we then examined data on children with the label "dyslexia". We first compared data concerning whether the child had a poor test result in the areas of reading, spelling and phoneme recognition as defined by the ability to read non-words.

Table 4 and Table 5 show that the proportion with very low test scores was much higher for children with external mothers (odds ratios varying between 1.58 and 2.28), or with external fathers (odds ratios of 1.58 to 2.26). Assessing the two parents together (Table 6) shows that the prevalence of low scores rose

Table 3. Prevalence [n] (odds ratios) of autism and severe autistic trait scores on measures of social communication (SCDC), pragmatic language (CCC coherence), repetitive behaviour and sociability temperament (EAS) by combination of maternal and paternal locus of control as measured in pregnancy.

OUTCOME	M.INT + F.INT	M.INT + F.EXT	M.EXT + F.INT	M.EXT + F.EXT	P-value
<i>Traits</i>					
SCDC	8.20% [198] (1.00R)	8.59% [113] (1.05)	9.93% [92] (1.21)	12.80% [158] (1.56)	< 0.001
Coherence	8.62% [202] (1.00R)	9.08% [108] (1.05)	9.78% [88] (1.13)	13.14% [148] (1.52)	< 0.001
Repetitive	6.36% [133] (1.00R)	6.10% [67] (0.96)	6.99% [60] (1.10)	8.82% [114] (1.39)	< 0.001
Unsociable	8.84% [243] (1.00R)	10.68% [161] (1.21)	12.80% [147] (1.45)	13.87% [223] (1.57)	< 0.001
<i>Diagnosis</i>					
ASD	1.40% [43] (1.00R)	1.28% [24] (0.91)	1.59% [23] (1.14)	0.81% [19] (0.58)	0.011

M.INT, mother internal; M.EXT, mother external; F.INT, father internal; F.EXT, father external.

Table 4. Prevalence [n] of poor scores in reading, spelling and phonemic decoding efficiency (PDE) at age 9 by maternal locus of control as measured in pregnancy.

Outcome	ILOC prevalence	ELOC prevalence	ELOC/ILOC	P-value
Word reading	9.8% [419]	16.9% [463]	1.87	< 0.0001
Comprehension	10.1% [392]	20.4% [507]	2.28	< 0.0001
Reading speed	10.7% [413]	18.4% [457]	1.89	< 0.0001
Reading accuracy	10.6% [412]	18.4% [456]	1.89	< 0.0001
PDE	13.4% [572]	19.7% [535]	1.58	< 0.0001
Spelling	12.0% [511]	18.1% [492]	1.62	< 0.0001
<i>Labelled</i>				
Dyslexia	4.5% [203]	4.5% [129]	1.01	0.960

ELOC = external locus of control; ILOC = internal locus of control; PDE phonemic decoding efficiency.

Table 5. Prevalence [n] of poor scores in reading, spelling and phonemic decoding efficiency (PDE) at age 9 by paternal locus of control as measured in pregnancy.

Outcome	ILOC prevalence	ELOC prevalence	ELOC/ILOC	P – value
Word reading	8.8% [262]	16.1% [355]	2.00	< 0.0001
Comprehension	9.1% [244]	18.4% [368]	2.26	< 0.0001
Reading speed	9.6% [258]	16.4% [326]	1.84	< 0.0001
Reading accuracy	9.0% [243]	17.2% [345]	2.10	< 0.0001
PDE	12.6% [377]	18.6% [408]	1.58	< 0.0001
Spelling	10.2% [304]	17.8% [391]	1.91	< 0.0001
<i>Labelled</i>				
Dyslexia	4.6% [147]	4.0% [94]	0.88	0.301

ELOC, external locus of control; ILOC, internal locus of control; PDE, phonemic decoding efficiency.

Table 6. Prevalence [n](odds ratio) of poor scores in reading, spelling and phonemic decoding efficiency (PDE) at age 9 by combination of maternal and paternal locus of control as measured in pregnancy.

Outcome	M.INT + F.INT	M.INT + F.EXT	M.EXT + F.INT	M.EXT + F.EXT	P - value
Word reading	7.6% [163] (1.00R)	12.8% [144] (1.68)	11.7% [98] (1.54)	19.6% [211] (2.58)	< 0.0001
Comprehension	7.3% [141] (1.00R)	13.1% [134] (1.79)	13.5% [123] (1.85)	24.0% [234] (3.29)	< 0.0001
Reading speed	8.0% [154] (1.00R)	12.3% [125] (1.54)	13.6% [103] (1.70)	20.7% [201] (2.59)	< 0.0001
Reading accuracy	7.9% [152] (1.00R)	13.3% [136] (1.68)	11.9% [91] (1.51)	12.5% [209] (1.58)	< 0.0001
PDE	11.8% [252] (1.00R)	15.7% [176] (1.33)	14.8% [124] (1.25)	21.8% [232] (1.85)	<0.0001
Spelling	9.9% [211] (1.00R)	15.0% [168] (1.52)	11.0% [92] (1.11)	21.0% [223] (2.12)	<0.0001
<i>Labelled</i>					
Dyslexia	4.4% [102] (1.00R)	3.8% [45] (0.85)	4.9% [44] (1.12)	4.2% [49] (0.96)	0.644

EXT,external; F, father; INT,internal; M, mother; R, reference value; PDE, phonemic decoding efficiency.

with the numbers of external parents. Indeed, the ratio of the proportions of children with low scores comparing both parents external with both parents internal varied from 1.58 for reading accuracy to 3.29 for comprehension. This pattern of increasingly poor performance in reading, spelling and phoneme tests with the number of external oriented parents is not reflected in the prevalences of reported dyslexia, where the proportions were similar across LOC categories.

Thus, we have a similar finding to that found with ASD – the test results of the children indicate that although offspring of external parents have much poorer reading abilities, they are not at increased likelihood of being labelled as dyslexic.

Stratification by social class

Our findings for the mothers in the study in regard to two autism and two dyslexia traits and the diagnoses of ASD and dyslexia are shown separately for non-manual and manual social classes in Table 7. For all four traits there are similar variations among both social class groups, with the prevalences of the extreme ends of each trait being higher among the children of external mothers compared with internal mothers. This comparison was consistent regardless of the fact that the prevalence of the extremes of each trait were considerably higher among the manual compared with the non-manual groups. Consequently, the ratios of the prevalences of extreme traits among external compared with internal mothers was greater than 1; this was true for each social class group (Figure 1). However, when the actual diagnoses were considered, the pattern was different for families in the manual social classes: here the ratio of prevalence of each diagnosis in external compared to internal mothers was substantially less than 1, whereas it was greater than 1 for those in the non-manual classes.

Discussion

In these analyses, although we found that extreme levels of those autistic traits that predicted a diagnosis of ASD were more prevalent if the mother had an ELOC, and especially if both parents

Table 7. Contrast between prevalences of most extreme levels of autistic and dyslexic traits and of prevalences of diagnoses for autism and dyslexia between two social class groups and the mother's locus of control.

Outcome	ILOC mothers: prevalence	ELOC mothers: prevalence	ELOC/ ILOC	P-value
<i>Non-manual group</i>				
Coherence	12.8% (375)	16.9% (208)	1.32	<0.0001
Unsocioable	16.3% (569)	20.1% (317)	1.23	0.001
Diagnosed autism	1.5% (61)	2.0% (39)	1.33	0.186
Reading test	7.7% (207)	12.3% (141)	1.60	<0.0001
Spelling	10.3% (279)	13.9% (160)	1.35	0.001
Diagnosed dyslexia	4.5% (131)	5.4% (65)	1.20	0.252
<i>Manual group</i>				
Coherence	15.7% (266)	19.4% (328)	1.24	<0.0001
Unsocioable	16.5% (355)	21.4% (531)	1.30	<0.0001
Diagnosed autism	1.0% (29)	0.5% (29)	0.50	0.020
Reading test	15.2% (241)	21.6% (346)	1.42	<0.0001
Spelling	16.9% (268)	22.8% (366)	1.35	<0.0001
Diagnosed dyslexia	4.3% (72)	3.8% (64)	0.59	0.479

ELOC, external locus of control; ILOC, internal locus of control.

had ELOC, a diagnosis of autism was made less frequently among children of ELOC parents than would be expected from the trait data.

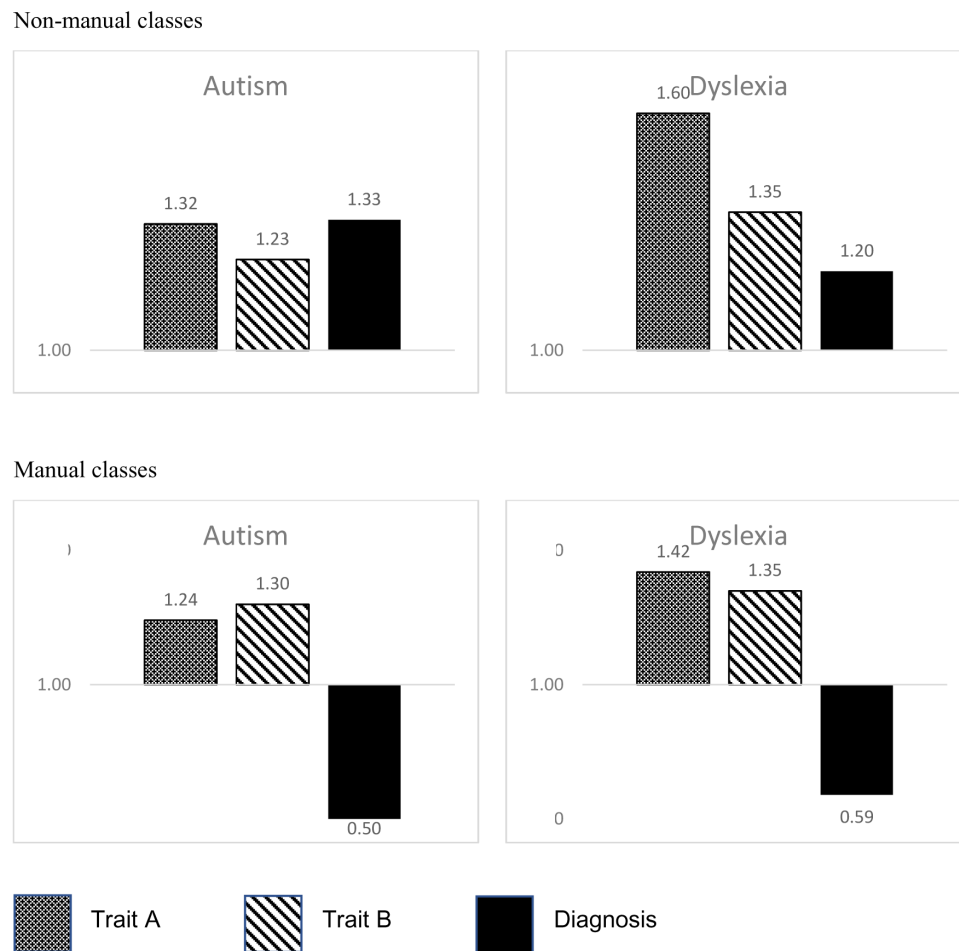


Figure 1. Ratios of the prevalence of extreme scores on traits, as well as on diagnosis split by whether the household was from a manual or non-manual social class.

In consequence, we raised the possibility that this phenomenon might be found for other diagnoses, and tested this on dyslexia. We found the same pattern as for ASD – although children of external parents were more likely to perform poorly in regard to reading and spelling, they were not more likely than those of internal parents to use that information to obtain the diagnostic label. We showed that the pattern for each diagnosis was such that there was an interaction with social class categorised in regard to the father's occupation, maternal internality being important for obtaining a diagnosis in the manual but not the non-manual classes.

There are at least three possible reasons to explain these findings: (1) the health and education personnel knew of the problems but had not conveyed the diagnostic labels to the parents or other key personnel; (2) the mother knew of the label but did not want to convey the information to the study; (3) the diagnosis had not been made even though the criteria for the diagnosis were apparent.

Explanation (1) is unlikely for autism since the information to identify children with ASD was obtained from a variety of sources

including health and education records, as well as the mother's report. Explanation (2) is possible but unlikely as the cohort parents have filled in many questionnaires on a variety of topics, often of a sensitive nature. Qualitative studies have shown that the ALSPAC participants have complete trust in the anonymisation process, and the study's integrity (Birmingham, 2018). Explanation (3) therefore seems the most likely.

In order to understand this, an explanation of the child health system in England is appropriate. Although the National Health Service is universally accessible without any payment required at the point of use, it does require parents to bring the child for assessments in relation to child health and development. Routine appointments for immunisations and developmental checks will be made, but whether or not the individual attends, is the responsibility of the parent(s). It has been shown that external parents are less likely to breast feed or to get their child fully immunised by 6 months of age – 16.9% of children were not immunised if both parents were external compared with 7.4% when both were internal, giving a ratio of both external to both internal of 2.28 to 1 (Nowicki *et al.*, 2017). It is more than

likely that the same pattern applies to attendance for child development checks.

Conversely, once the child is attending school (from age 4), any behavioural abnormalities are likely to be observed by the teacher. Whether these observations are taken further is again likely to depend to some extent on the parents. The teacher may convey the problem to the parent at a parent-teacher meeting, provided the parent attends. However, it has been shown elsewhere that external parents are less likely to show an interest in the child's schooling and less likely to attend regular parent-teacher meetings (Golding *et al.*, 2019). It is frequently reported that it is more likely for 'a pushy parent' to get a diagnosis for their child (Times Education Supplement, 2017) – such parents may be more likely to be internally oriented. Consistent with the characteristics of internal problem-solving approaches noted in the introduction, internals are more likely than externals to gather relevant information and then persist in using that information to solve their problem. Their goal is to get extra (free) help for their child in school – and this is particularly facilitated in the UK if the child has a diagnostic label. Our social class findings raise a different set of issues. It could be that the health and teaching professions take more notice of enquiries from parents in the non-manual classes. Alternatively, the professionals may assume that poor literacy or unusual behaviour in children from manual social classes are normal for that community and fail to investigate further.

Conclusion

A key question, however, concerns whether the possession of a diagnostic label matters. If it does and the results of the present study are confirmed by others, then focusing on the LOC of parents becomes important. Previous studies have found that parental externality is associated with negative children's outcomes, but also that children's difficulties are reduced when parents become more internal (Nowicki *et al.*, 2018a; Nowicki *et al.*, 2018b). This suggests that time could be spent helping parents to become more appropriately internal. Nowicki (2016a) reported a number of possible ways of accomplishing that goal including counselling, but randomised controlled trials are needed to ensure that such interventions are efficacious.

Strengths and limitations of the data

The strengths of these data include the large sample size, with over 20,000 participants with data available (Boyd *et al.*, 2013).

The only inclusion requirements at enrolment for this study were the geographical location the participating mother resided in and the expected date of delivery. The participants recruited to the study were broadly representative of the general population of new parents' resident in the area at the time in terms of sex, ethnicity and socio-economic status (Fraser *et al.*, 2013).

A key limitation of the study is the lack of ethnic diversity. At the time of enrolment, the county of Avon was mainly Caucasian, therefore there were too few Black, Asian and Minority Ethnic (BAME) participants (<6% in total) to allow for detailed analysis by ethnic background.

Data availability

ALSPAC data access is through a system of managed open access. The steps below highlight how to apply for access to the data included in this paper and all other ALSPAC data.

1. Please read the ALSPAC access policy (http://www.bristol.ac.uk/media-library/sites/alspac/documents/researchers/data-access/ALSPAC_Access_Policy.pdf) which describes the process of accessing the data and biological samples in detail, and outlines the costs associated with doing so.
2. You may also find it useful to browse our fully searchable research proposals database (<https://proposals.epi.bristol.ac.uk/>), which lists all research projects that have been approved since April 2011.
3. Please submit your research proposal (<https://proposals.epi.bristol.ac.uk/>) for consideration by the ALSPAC Executive Committee using the online process. You will receive a response within 10 working days to advise you whether your proposal has been approved.

If you have any questions about accessing data, please email: alspac-data@bristol.ac.uk (data) or bbl-info@bristol.ac.uk (samples).

Acknowledgements

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This well written article (by a stellar team with an unbelievable track record,) find external parental locus of control (LOC) is associated with dyslexic and autistic traits, whilst diagnosis of both conditions is associated with parent's internal locus of control.

It concludes that children of parents with an externally oriented Locus Of Control may be less likely to be diagnosed "appropriately" than children of internally oriented parents. Interventions to increase parental internality may improve the likelihood of appropriate diagnoses and hence an improvement in child well-being.

I enjoyed the article in an admittedly under-researched area, but would like to see a shift of focus which would underpin a more solid contribution.

The authors talk about "a presumed diagnosis of autism" yet having a diagnosis or not is a major topic in this work, as currently positioned, we are not really certain if children have one or not. As the authors know, educational records, parent report etc can be misleading. Also, the cut-off of traits at 10% or thereabouts is far too mild to reveal 'diagnosable' autism, so it is misleading to say 'criteria for dx' were apparent. And top 10% of people in autistic traits may be so mild as to not pose them any real problems rendering diagnosis unnecessary.

Instead what is I'd like to see is more speculation for the observed association between ILOC and autistic/dyslexic traits. The authors don't speculate as to why we see this association. And what are the clinical and wider societal implications of this link?

Additional questions/comments

Introduction:

Please delineate more clearly why the work is important and the rationale for the work in the introduction

To what extent can LOC be considered as fixed trait and what extent influenced by life

circumstances? Is it considered primarily inherited or due to upbringing?
How is LOC related to SES- presumably ILOC is associated with higher SES but please let us know.

Methods:

Traits - why used top 10% - please justify.

Were dyslexia measures subject to same cut offs?

Ex LOC defined as around 40%- how was ILOC measured and defined? Were all parents defined as either one or the other?

What is repeat reliability of LOC measure?

Assuming dyslexic abilities ie reading and spelling skills are fixed traits the same throughout all ages (a similar assumption that made for autistic traits)- is a limitation. Clearly reading and spelling skills depend on exposure and quality of education as well as more internal child-based factors. That is why dyslexia is normally defined by the discrepancy model- it is unexpectedly poor reading and spelling ability *given a level of cognitive competency and adequate opportunity to learn comparable to peers*.

What were the numbers in the analyzed sample?

Why not use ANOVA and compare between the continuous traits scores between ILOC and ELOC on continuous scales for traits rather than cut-offs? Cut-off also it entail a loss of power.

Results

Please give CIs for ORs not just p values.

If you keep the focus on diagnosis versus top 10% traits then report how many with dx were in top 10% for both categories – the sensitivity and specificity, and positive predictive value, based on assumed diagnosis.

I would recommend you use traits as continuous measure and focus on associations more rather than getting tangled up in whether trait is reliable way to see whom should receive dx.

Discussion

Discussion of why ELOC parents may not label is helpful. Labelling could be to do with over-controlling parents too- there are many studies that might be framed as being about parents inappropriate ILOC as well as their 'appropriate' ILOC?

Could SES be a confounder?

Key Q to me is is WHY are there children with autistic and dyslexic traits more likely to come from ELOC parents?

Is the work clearly and accurately presented and does it cite the current literature?

Yes

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

Yes

If applicable, is the statistical analysis and its interpretation appropriate?

Partly

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Neurodevelopmental disorders/neurodiversity

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.
